



ABSTRACT OF THE DISCLOSURE
LIQUID SENSOR AND ICE DETECTOR

An improved apparatus and a method of measuring and interpreting reliably, simply and accurately the information on continuous liquid level, liquid temperature and other liquid properties within a vessel. The apparatus could be made of a powered heater element and temperature sensors can be screen-printed, vacuum deposited, etched, welded, soldered or plated on one or both sides of a single rigid or a flexible substrate. The powered heater element used in this invention is similar to a hot wire. While in a hot wire technology the electrical resistance of the wire is used to determine the liquid level, in this invention the heater geometry is used to obtain a temperature profile or a wave like temperature distribution that moves up and down the heater. Due to non-uniformity and localized effects in the liquid and the medium above it, the hot wire technology gives large errors in its reading of the liquid level. In contrast, in the method and apparatus of this invention, localized and non-uniform effects within the liquid or the medium above it will be distributed over the entire temperature profile and will not significantly change the shape of the temperature profile. The geometry of the heater determines the curve shape, such as steepness or shallowness of a temperature profile along a heater. The geometry of the heater will control the spacing of the temperature sensors. The temperature sensors measure the actual temperature of the heater at a few points along the heater. The temperature sensors must be located close to the heater. When

thermocouples are used to measure the temperature along a heater the thermocouples can be configured in parallel with a common cold junction or in a series with a common temperature for all of the cold junctions. The hot junctions of thermocouples configured in parallel or in series are located close to the heater. Cold junctions of thermocouples are located at a point away from the heater. Various parallel and serial configurations of thermocouples or temperature sensors can be used to measure the temperature along a heater. Simultaneous measurements from all the temperature sensors, before and after heat is applied, are used to generate accurate temperature profiles for the entire heater and not just from two adjacent temperature sensors. Different features of the temperature profiles will determine accurately the liquid level, liquid temperature and other liquid properties. Apparatus of the invention may also be used to detect ice formation.